explored medium, that is to say a medium subjected to ultrasound signals emitted and received by an echography apparatus. The invention is based on the processing of the echographic signal in order to determine the distribution of the elasticity modulus in the explored medium while using a regularized inverse solving method, applied to data of a field of displacements measured in said medium. The invention can be very attractively applied for the detection of malignant tumors by determination of the distribution of the elasticity modulus in the tissues, as well as for the determination of the size of such tumors.

The medium in FIG. **1** is, by way of example, breast tissue which is called texture **11**. A continuously variable pressure P is applied to the breast tissue and a displacement field is determined by subjecting a region of the tissue to ultrasound signal excitations and by applying a correlation method to the ultrasound signals. More specifically, the pressure P continuously increases and is applied by means of a compressor **12** which is driven by a motor **13**. The zone **11** of the breast tissue which is subjected to the compression has a fixed face F**1** whereto a probe **10** of an echography apparatus **100** is applied, and a parallel face F**2** whereto the pressure P of the compressor is applied in the perpendicular direction. In the device according to the invention as shown in FIG. **1**, the mobile wall of the compressor **12** applied to the face F**2** is displaced in the direction of the face F**1** at a given speed $\vec{v}$. The probe **10** applied to the fixed face F**1** applies RF signals to the texture **11** during excitations parallel to the direction of the face F**2**. The excitation lines along the axis Z extend perpendicularly to the faces F**1** and F**2** and parallel to the direction of the pressure of the compressor **12**. The excitations are produced by the echography apparatus **100** which includes a system **110** for focusing the RF signals in the tissue **11**, parallel to an axis Z, and for scanning by way of the excitation signals RF linearly parallel to an axis X which extends parallel to the face F**1**. The scanning according to the axis X is performed along a given number of N excitation lines with a recurrent period T. When the N excitations from 1 to N parallel to Z have been performed, the probe starts anew with N excitations from 1 to N with a period NT for a given excitation line. The probe in return receives from the texture **11** the echographic signals which are applied to an elasticity variation detection system **200**. Preferably, the probe consists of an array of linear detectors emitting recurrent excitations. The system **200** includes a 1-bit temporal correlation system **210** for performing in real time the correlation of each of the signals transmitted by the probe and originating from a given location in the texture **11**. The correlation system **210** executes the correlation of signals relating to two successive excitations of the probe and originating from a given location, and provides the amplitude of the displacements of each point of the structure **11** explored by the probe on each excitation line. During the operation of the compressor **12**, this method supplies, continuously and in real time, an image of the displacement field of the structures forming the texture **11**.

To this end, the image of the displacement field in the zone of the explored texture **11** is discretized. The signals produced by the various scans by the probe are not stored. These signals are correlated directly by the 1-bit temporal correlation system **210** which provides an image of the displacements of each point of the structure, for example in the form of iso-displacement lines as illustrated in FIG. **3**. The present method also involves specific means for making the determination of the distribution of the elasticity modulus distribution resistant to noise in order to realize, in combination with a reconstruction of the elasticity modulus distribution which is realized in real time, a reconstruction which is less noisy than that achieved according to the state of the art.

It is to be noted that the displacements calculated by the correlation system **210** result from direct measurements of the displacements of the structures of the region explored by means of the echography apparatus. These displacements are radial, parallel to the pressure P and are obtained under the influence of said external pressure P exerted on the tissue **11**.

Preferably, several series of scans are performed while using therebetween an equal compression or a displacement, equal to $\vec{v}\times NT$, of the face F**2** of the compressor, followed by averaging of the data supplied by the correlation system **210**. This method enables a high precision to be achieved in this step **210** for the acquisition of the displacement field.

In the step **210** the data of the displacement field is calculated in the form of elementary displacements $d_1, \ldots d_i \ldots d_n$ for each pixel of the discretized ultrasonic image obtained by way of the correlation method. The data of the elementary displacements constitutes a displacement data vector $\underline{d}$.

This displacement vector $\underline{d}$ is linked to a so-called elasticity modulus vector (or Young modulus)$\underline{e}$ by a direct relation F which is written as (1):

$$\underline{d}=F(\underline{e}) \tag{1}$$

The elasticity modulus vector $\underline{e}$ is formed by elementary elasticity moduli $e_1, \ldots e_i \ldots e_n$ which correspond to the respective elementary displacements relating to each pixel $p_1, \ldots p_i, p_n$ of the discretized image. It is known that $F(\underline{e})$ is the image realized by means of a Finite Element Model of the distribution of the elementary elasticity moduli, that is to say of the vector $\underline{e}$. A Finite Element Model is a calculation technique which can be applied to the elasticity equations and is known to those skilled in the art.

The problem to be effectively solved is the determination of the vector $\underline{e}$ giving the distribution of the elasticity modulus in the explored region having produced the displacement field. The determination of the vector $\underline{e}$ enables the formation of an image of the elasticity modulus distribution which is formed by elementary moduli relating to each pixel of the discretized image.

The value of the vector $\underline{e}$ is obtained, on the basis of the relation (1), by solving the inverse problem according to the relation (2):

$$\hat{e}=\arg\min[\|d-F(\underline{e})\|^2] \tag{2a}$$

where $\hat{e}$ is an estimator of $\underline{e}$. The estimator $\hat{e}$ of the elasticity modulus $\underline{e}$ minimizes the distance $\|d-F(\underline{e})\|^2$ between the data d acquired by means of the measurements in the step **210** of FIG. **1** and the image $F(\underline{e})$ realized by means of the Finite Element Model. The estimator $\hat{e}$ enables determination of the vector $\underline{e}$ which, once it has been inserted into the Finite Element Model, yields a value of the vector $\underline{d}$ which approximates as closely as possible the vector $\underline{d}$ measured in the step **210**.

The relation (2a) is known from the publication cited as the state of the art and is called the Newton-Raphson algorithm. This algorithm enables calculation of the minimum value of the distance $\|d-F(e)\|^2$ in an iterative manner, for example by means of 10 or 15 iterations according to the state of the art. The Newton-Raphson algorithm utilizes an iterative minimization of the distance which is written as: